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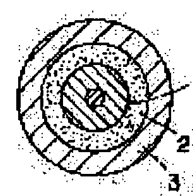
(54) **SINGLE CORE OPTICAL FIBER CORD**

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a single core optical fiber cord of an outside diameter of ≤1mm which has a coated fiber pushing-in property, cord flat rate and tensile characteristic at a level having no problems in use and satisfies such transmission characteristics as bending characteristic, side pressure characteristic and temp. characteristic.
SOLUTION: The thickness of the thermoplastic resin sheath 3 of the single core optical fiber cord which is arranged with a coated optical fiber 1 at its center, is provided with a tensile fiber layer 2 on its outer periphery and further the thermoplastic resin sheath 3 on its outer periphery and is formed to the outside diameter of ≤1mm is specified to ≥0.15mm and the 100% modulus thereof is specified to ≥15MPa. The cross sectional occupying rate of the tensile fiber between the coated optical fiber 1 and the thermoplastic resin sheath 3 is specified to 50 to 80%.



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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed description]
[0001]
[The technical field to which invention belongs] As for this invention, an outer diameter is related with a single core optical fiber code 1mm or less.
[0002]
[Prior art] Various properties, such as transmission characteristics, such as mechanical properties, such as a **** property, bending rigidity, and abrasion resistance, a lateral-pressure property, the temperature characteristic, and a bending property, and fire retardancy, are required of an optical fiber code. In order to satisfy these various properties, the conventional single core optical fiber code used within the enclosure of an office has the following structures.
[0003] That is, the conventional single core optical fiber code is the structure which has arranged focusing on nylon covering optical fiber core wire with an outer diameter of 0.9mm, prepared the tensile-strength fiber layer which gathered the tensile-strength fiber of modulus-of-elasticity-in-tension 110-150GPa by ****** on the periphery, and prepared PVC (polyvinyl chloride) sheath in the periphery further. Aramid fibers (a tradename Kevlar, ********, etc.) are used as tensile-strength fiber. The outer diameter (sheath outer diameter) of a code has 2 commonmm with this structure.
[0004]
[Object of the Invention] In connection with the expansion of an optical-communication enterprise in recent years, maintenance of a fiber optic cable network is progressing and high-density multi-core-ization of a cable is attained in connection with this. Although many single core optical fiber codes are used for the so-called optical wiring module which makes connection of office termination and an office fiber optic cable, it is pressed also for the single core optical fiber code in connection with the formation of high-density multi-core of a cable by the need corresponding to it.
[0005] However, if it assumes that the number of wirings increases 4 to 6 times over the past when the storage space of the optical fiber code in an optical wiring module is taken into consideration, in a single core optical fiber code with an outer diameter of 2mm, correspondence will become impossible. When prospective correspondence is taken into consideration, it is surely necessary to set the outer diameter of a single core optical fiber code to 1mm or less. If it is merely going to diameter[of thin]-ize a code with a conventional outer diameter of 2mm only, use of nylon covering optical fiber core wire with an outer diameter of 0.9mm will become impossible, and the amount of tensile-strength fiber will decrease, and problems -- a mechanical property falls -- will arise. Moreover, the problem that the bending rigidity of a single core optical fiber code falls by diameter[of thin]-izing itself is also produced.
[0006] The purpose of this invention is 1mm or less in outer diameter, and is to offer the single core optical fiber code which had sufficient **** property, bending rigidity, and the transmission characteristic with the sufficient balance on use.
[0007]
[The means for solving a technical problem] In order to attain this purpose, this invention is arranged focusing on the optical fiber core wire which has resin covering, a tensile-strength fiber layer is prepared in the periphery, a thermoplastics sheath is further prepared in the periphery, the aforementioned thermoplastics sheath is carried out in thickness of 0.15mm or more in the single core optical fiber code which set the outer diameter to 1mm or less, and it is characterized by a modulus consisting of a resin of 15 or more MPas 100%.
[0008] 100% modulus is an index which shows the tensile strength at the time of 100% elongation, and shows the same property as a modulus of elasticity in tension. It means that an elastic modulus is so large that this is large.
[0009] A connector is attached in a terminal and a single core optical fiber code connects this to an optical wiring module by a man's hand. For this reason, at the time of connection work, tensile force is applied to a single core optical fiber code. Moreover, it may be in the status [that a single core optical fiber code is pulled by the method of a wiring]. Although near the connector anchoring section of a single core optical fiber code is protected by the reinforcement tube of the rubber quality of the material, since a single core optical fiber code has low rigidity, when it is perpendicularly pulled to a connector, it will receive extreme bending near the terminal section of a reinforcement tube. A transmission loss arises for this bending. Moreover, fracture of an optical fiber may arise by the case. An outer diameter bends in a single core optical fiber code 1mm or less, and since rigidity is low, such a problem appears notably especially.
[0010] If the thickness of a thermoplastics sheath has an outer diameter thinner than 0.15mm in a single core optical fiber code 1mm or less, even if it uses general lagging materials, such as PVC and polyethylene, the above-mentioned problem will not be

solved. The thickness of a thermoplastics sheath is required 0.15mm or more. Moreover, even if the thickness of a thermoplastics sheath is 0.15mm or more, 100% modulus of the thermoplastics for sheaths does not solve the problem of the parvus and the above too from 15MPas. The thermoplastics for sheaths requires that 100% modulus should be 15 or more MPas. if a parvus resin tends to be used for a sheath from 15MPas and it is going to raise the bending rigidity of a single core optical fiber code -- the thickness of a sheath -- thick -- not carrying out -- it cannot obtain and a code outer diameter cannot be pressed down to 1mm or less The conventional single core optical fiber code had 100% modulus of a thermoplastics sheath smaller than 15MPas.

[0011] The material of a thermoplastics sheath has fire retardancy and should just fulfill the above-mentioned property. As such a material, although there are PVC, fire-resistant polyethylene, etc., it is desirable to use PVC in that it is cheap and general-purpose.

[0012] If the optical fiber core wire used for this invention has covering of the resin with large Young's modulus in the outermost layer, there is especially no limit. For example, UV resin (ultraviolet-rays hardenability resin) covering core wire, nylon covering core wire, etc. can be used. Moreover, also about the structure of optical fiber core wire, the two-layer type with which primary ** / ********** material used UV resin, and the three layer type which covered the overcoat over the diameter optical fiber core wire of 250 micrometer generally used, and considered as the necessary outer diameter are usable. As three layer type overcoat material, nylon and UV resin are usable.

[0013] The outer diameter of optical fiber core wire is 0.35-0.55mm, and is 0.4-0.5mm preferably. 0. The parvus and a lateral-pressure property are not securable from 35 mm. Moreover, if larger than 0.55mm, the rate of the core wire occupied to the code cross section will become large too much, reservation of the amount of tensile-strength fiber to need becomes difficult, or a sheath becomes thin too much, and problems -- a sheath piece becomes easy to happen -- arise.

[0014] Tensile force is applied to a single core optical fiber code as mentioned above in the case of connection work etc. As a standard of the **** property required of a single core optical fiber code, if the tensile strength of a code is more than 69N to 0.5% of elongation, optical fiber asymmetry is equivalent to the former, and a problem does not have it.

[0015] The aramid fiber was used in order that a single core optical fiber code with a conventional outer diameter of 2mm might secure a **** property. Also in the single core optical fiber code in this invention, if a **** property is securable, use of an aramid fiber is possible. Moreover, it is desirable to use PBO (******** phenylene ********** oxazole) fiber as tensile-strength fiber in this invention. The modulus of elasticity in tension has one twice [more than] the elastic modulus [about 250 GPas and] of an aramid fiber, and by using this PBO fiber, PBO fiber can reduce the amount of tensile-strength fiber sharply, and has the advantage to which the degree of freedom of a design spreads.

[0016] The amount of tensile-strength fiber to need can be extended with the elastic modulus of fiber, and can be calculated from the relation of asymmetry. What is necessary is just to be more than about 780 denier (elastic-modulus 25300kg/mm2) more than about 1650 denier (elastic-modulus 11100kg/mm2) on a calculation, if it is PBO fiber, if it is an aramid fiber (tradename Kevlar 49). However, not only the tensile strength of tensile-strength fiber but the cross-section pulse duty factor of the tensile-strength fiber between the periphery side of optical fiber core wire and the inner skin of a thermoplastics sheath understood the **** property of a single core optical fiber code in fact from the result that whose it is involving greatly it is an experiment.

[0017] If the cross-section pulse duty factor of tensile-strength fiber is small even if it is the amount of tensile-strength fiber which is on a calculation and can be found, the so-called play will be made to tensile-strength fiber between optical fiber core wire and a sheath, and the problem that tension will be applied to the optical fiber itself, without the tensile strength of tensile-strength fiber involving at all will arise at the time of the initial elongation when being pulled. Conversely, since the optical fiber core wire in a connector is pushed in the orientation of an axis, complementary length is produced and this complementary length is not contained in a code when connecting the connector attached in the code with the other party, if the cross-section pulse duty factor of tensile-strength fiber is too large, there is a possibility of optical fiber core wire bending and starting a buckling.

[0018] It is desirable to set to the single core optical fiber code of this invention, since it is such, and to **** the cross-section pulse duty factor of the tensile-strength fiber between the periphery side of optical fiber core wire and the inner skin of a thermoplastics sheath to 50 - 80%. If the cross-section pulse duty factor of tensile-strength fiber is ****ed to 50% or more, there is little complementary length of the tensile-strength fiber contained in a code, and since the force in which the function of tensile-strength fiber is demonstrated and it is applied to optical fiber core wire is small and ends, the amount of asymmetry of an optical fiber can be small stopped in the state of the first stage when tensile force was applied to the code. Moreover, if the cross-section pulse duty factor of tensile-strength fiber is ****ed to 80% or less, when a connector will be attached in a code and a connector will be connected mutually, even if optical fiber core wire is pushed in the orientation of an axis, a possibility of starting a buckling becomes not few.

[0019]

[Gestalt of implementation of invention] Drawing 1 shows the single core optical fiber code which has arranged focusing on the optical fiber core wire 1, formed the tensile-strength fiber layer 2 in the periphery, and formed the thermoplastics sheath 3 in the periphery further. The single core optical fiber code of the various configurations shown in Table 1 (examples 1-6), 2 (examples 7-12), and 3 (examples 1-6 of a comparison) was manufactured, and such a single core optical fiber code measured and estimated various properties. In addition, in Table 1 - 3, UV expresses UV resin and Ny expresses nylon.

[0020]

[Table 1]

実施例		1	2	3	4	5	6
構成	光ファイバ心線：						
	プライマリ被覆樹脂と	UV	UV	UV	UV	UV	UV
	その外径（μm）	200	200	200	200	200	250
	セカンダリ被覆樹脂と	UV	UV	UV	UV	UV	UV
	その外径（μm）	250	250	250	250	250	500
	オーバーコート樹脂と	UV	UV	UV	Ny	UV	なし
	その外径（μm）	350	400	450	450	500	
	抗張力繊維：						
	アラミド繊維（denier）	1900	1900	1900	1900	1900	1900
	断面積占有率（%）	50	67	64	71	77	77
	ＰＶＣシース：						
	厚さ（mm）	0.15	0.17	0.15	0.16	0.15	0.15
	100 %モジュラス(MPa)	17	17	15	15	17	17
	コード外径（mm）	1.0	1.0	1.0	1.0	1.0	1.0
機械特性	心線押し込み性	○	○	○	○	○	○
	コード偏平率	○	○	○	○	○	○
	引張特性	○	○	○	○	○	○
	曲げ特性	○	○	○	○	○	○
伝送特性	側圧特性	○	○	○	○	○	○
	温度特性	○	○	○	○	○	○

[0021]
[Table 2]

実施例		7	8	9	10	11	12
構成	光ファイバ心線：						
	プライマリ被覆樹脂と	UV	UV	UV	UV	UV	UV
	その外径（μm）	200	250	200	250	200	200
	セカンダリ被覆樹脂と	UV	UV	UV	UV	UV	UV
	その外径（μm）	250	500	250	500	250	250
	オーバーコート樹脂と	UV	なし	Ny	なし	Ny	UV
	その外径（μm）	550		450		450	400
	抗張力繊維：						
	ＰＢＯ繊維　(denier)	970	970	970	1455	1455	1455
	断面積占有率（%）	70	65	56	71	73	66
	ＰＶＣシース：						
	厚さ（mm）	0.15	0.19	0.20	0.17	0.19	0.20
	100 %モジュラス(MPa)	17	17	15	17	17	15
	コード外径（mm）	1.0	1.0	1.0	1.0	1.0	1.0
機械特性	心線押し込み性	○	○	○	○	○	○
	コード偏平率	○	○	○	○	○	○
	引張特性	○	○	○	◎	◎	◎
	曲げ特性	○	◎	◎	○	◎	◎
伝送特性	側圧特性	○	○	○	○	○	○
	温度特性	○	○	○	○	○	○

[0022]
[Table 3]

比較例		1	2	3	4	5	6
構成	光ファイバ心線：						
	プライマリ被覆樹脂と	UV	UV	UV	UV	UV	UV
	その外径（μm）	200	200	200	250	200	200
	セカンダリ被覆樹脂と	UV	UV	UV	UV	UV	UV
	その外径（μm）	250	250	250	500	250	250
	オーバーコート樹脂と	UV	UV	UV	なし	Ny	UV
	その外径（μm）	300	350	400		400	500
	抗張力繊維：						
	アラミド繊維（denier）	1900		1900	1900		
	ＰＢＯ繊維　（denier）		1455			970	1455
	断面積占有率（%）	46	56	83	63	39	55
	ＰＶＣシース：						
	厚さ（mm）	0.15	0.20	0.19	0.13	0.19	0.15
	100 %モジュラス(MPa)	17	10	17	17	17	12
	コード外径（mm）	1.0	1.0	1.0	1.0	1.0	1.0
機械特性	心線押し込み性	○	○	×	○	○	○
	コード偏平率	×	○	○	○	○	×
	引張特性	×	○	○	○	×	○
	曲げ特性	○	×	○	×	○	×
伝送特性	側圧特性	×	○	○	○	○	○
	温度特性	○	○	○	○	○	○

[0023] The evaluation technique of various properties is as follows.
The sheath of a "core-wire pushing nature" single core optical fiber code is removed about 3cm, optical fiber core wire was exposed, and in the status that a part for a code section was gripped, when the exposed optical fiber core wire was pushed in in the orientation of a code axis by the constant stress of 1kgf, optical fiber core wire made rejection (x) success (O) and the thing 2mm or less for what is pushed in in 2mm or more code.
[0024] The shape property of a "code oblateness" single core optical fiber code measured and evaluated the oblateness of a code. The oblateness of a code was calculated by {(maximum outer-diameter-minimum outer diameter)/minimum outer-diameter} x100(%), and this value made rejection (x) the thing larger than success (O) and it for 20% or less of the thing.
[0025] The **** property of a "**** property" single core optical fiber code measured and evaluated asymmetry (%) of an optical fiber. The test condition of a **** property was a part for 50mm/of 10m and the speed of testings between the marked lines, used the frequency modulator and measured the amount of asymmetry of an optical fiber from the phase change when the tensile strain are applied to an optical fiber. System of measurement is shown in drawing 2 . As for a frequency synthesizer and 12, 11 is [the electrical and electric equipment/phototransducer, and 13] tensilon by which in light/electric transducer, and 15 a vector voltmeter and 16 apply a recorder and 17 applies [a measuring beam-ed fiber code and 14] tension to the measured single core optical fiber code 13. O'clock of tension made [the thing beyond 69N] the parvus thing rejection (x) for the thing beyond success (O)98N 0.5% of the elongation asymmetry [N / (O)69] whose **** property is an optical fiber.
[0026] As shown in "bending property" drawing 3 , the end side of a single core optical fiber code is fixed, and it considers as the shape of support-at-one-end ******, using the other end as the free end, a 5g load is applied in position of 200mm from the holddown-member end face of the code, and distance X from a holddown-member end face to a code is measured under 50mm from a code fixed position. This distance X made [the thing 20mm or more] the parvus thing rejection (x) for success (O) and the thing 30mm or more from (O) and 20mm.
[0027] About the lateral-pressure property, the load of 490N was added to 10cm of single core optical fiber codes among "lateral-pressure property" transmission characteristics, and the increase in transmission loss on the measurement wavelength of 1.55 micrometers made rejection (x) the thing larger than success (O) and it for the thing 0.1dB or less.

[0028] The temperature characteristic as environmental capability-proof ["temperature characteristic"] put the flux of an optical fiber code into the thermostat, and the increase in transmission loss on 3 cycles, or ** and measurement wavelength of 1.55 micrometers made [the -10 degrees C - +40 degrees C thermo cycle] rejection (x) the thing larger than success (O) and it for the thing 0.1dB [/km] or less.

[0029] The result of Table 1 or 3 shows the following thing. The examples 1-12 of this invention satisfy each property. On the other hand, although the example 1 of a comparison is an example for which the outer diameter of optical fiber core wire used the parvus thing from 0.35mm, a lateral-pressure property becomes bad among transmission characteristics in this case. Moreover, for a parvus reason, the complementary length of the tensile-strength fiber within a code becomes [the cross-section pulse duty factor of tensile-strength fiber] large from 50%, the elongation asymmetry of an optical fiber becomes large, and it stops satisfying a **** property. Moreover, the oblateness of a code also becomes large.

[0030] Although the example 2 of a comparison is an example to which the modulus used parvus PVC for the thermoplastics sheath from 15MPas 100%, in this case, PVC sheath ** bends at least 0.15mm or more, and a property will become bad. Although the example 3 of a comparison thickens PVC sheath **, **** of a code is stopped and the cross-section pulse duty factor of tensile-strength fiber is ****ed to 50% or more, the cross-section pulse duty factor of tensile-strength fiber exceeds 80%, and since it is too large, the amount of pushing into the code of optical fiber core wire is small, and produces trouble in connector anchoring.

[0031] Although the example 4 of a comparison is an example which made PVC sheath ** smaller than 0.15mm, it brings the result to which the bending rigidity as a code becomes weak in this case, and the bend radius in the connector anchoring section becomes small too much. For a parvus reason, the elongation asymmetry of an optical fiber becomes [the cross-section pulse duty factor of tensile-strength fiber] large in [% / 50] this case, and it will become impossible that it is satisfied of a **** property although the example 5 of a comparison used PBO fiber for tensile-strength fiber, it bent by thickening sheath **, the property was improved, code **** was lost and it is an example. The example 6 of a comparison is an example for which the modulus used the parvus PVC sheath from 15MPas 100%, and in this case, at least 0.15mm of sheath ** will be weak to bending, and the oblateness of a code will also become large.

[0032]

[Effect of the invention] As explained above, according to this invention, core-wire pushing nature, a code oblateness, and a **** stuffed animal are in the level without a use top problem, and the single core optical fiber code with an outer diameter of 1mm or less which satisfies the value as which it moreover bends and the transmission characteristic of a property, a lateral-pressure property, and the temperature characteristic is required of a single core optical fiber code can be obtained. Therefore, if this single core optical fiber code is used, there is an effect remarkable in multi-core-izing of an optical cable.

[Translation done.]